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(54) Electrostatic dispensing apparatus and method

(57) An electrostatic dispensing system (10) for dispensing flowable material (12) on a moving substrate. The electrostatic dispensing system preferably includes a dispensing nozzle (16) supported in spaced, non-contacting relationship on one side of the moving substrate (14) and an electrostatic field generator (26) supported in spaced, non-contacting relationship on the opposite side of the moving substrate (14). The electrostatic field generator (26) is operable to generate an electrostatic field through the moving substrate (14), which itself is substantially non-conductive, for attracting flowable material (12) from the dispensing nozzle (16) in a series of spaced, continuous streams or beads (24) which intersect a surface of the moving substrate (14) facing the nozzle (16). The beads of flowable material (12) are deposited on the surface of the moving substrate (14) in a series of uniform, continuous beads (24) which are formed generally parallel to a direction of travel of the moving substrate (14). Methods of electrostatically dispensing flowable material on a moving substrate are also disclosed.

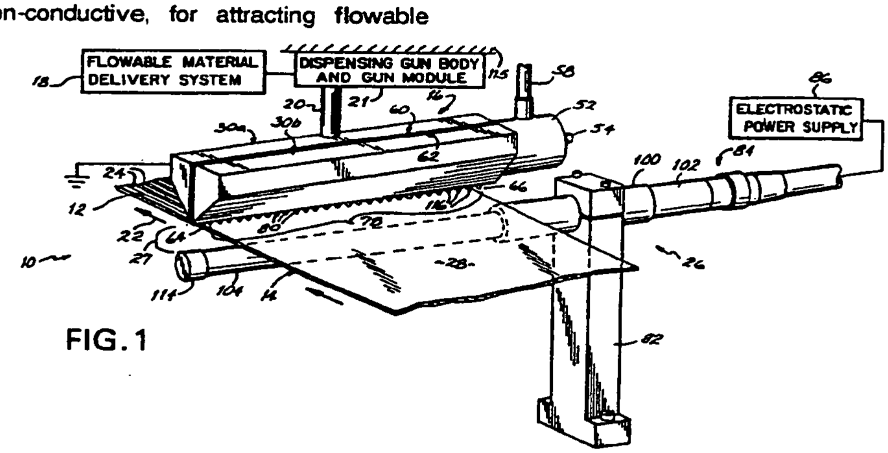

FIG. 1

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Description

Field of the Invention

[0001] The present invention relates generally to non-contact dispensing systems for dispensing flowable material on a substrate and, more particularly, to an electrostatic dispensing system having a dispensing nozzle and an electrostatic field generator for dispensing flowable material on a moving substrate.

Background of the Invention

[0002] In known electrostatic dispensing systems and processes for electrostatically dispensing flowable materials on a substrate, the flowable material is typically dispensed from one or more dispensing outlets and directed toward a target surface of the substrate. The dispensing outlet of the electrostatic dispenser may comprise either a series of closely spaced nozzles or an elongated slot which receives flowable material at a controlled flow rate and hydrostatic pressure from a fluid delivery system. Where spray nozzles are used as dispensing outlets, the flowable material is typically atomized into a fine particle spray for providing a uniform coating on a surface of the substrate. A dispensing nozzle having an elongated slot outlet, on the other hand, typically provides either a series of spaced, continuous beads of flowable material or a series of spaced, discontinuous streams of droplets which are applied to the surface of the substrate.

[0003] The flowable material in an electrostatic dispensing process is electrically biased relative to the target substrate to cause an electrostatic force attraction between the dispensed material and the substrate. The electrostatic force is created by electrically charging components of the dispensing nozzle in contact the flowable material, while the electrically conductive substrate is simultaneously grounded. The required charging voltage for the dispensing nozzle is provided by coupling a high voltage power supply, generally having an output voltage range between 10-50 kV, to conductive components of the dispensing nozzle in contact with the flowable material. In this way, the voltage potential created between the charged dispensing nozzle and the grounded substrate creates an electrostatic force which causes the charged continuous beads or discontinuous droplets of material to be attracted to the grounded substrate.

[0004] Electrostatic dispensing systems having charged dispensing nozzles are generally not well suited for dispensing applications which require heating of the nozzle to melt the flowable material prior to dispensing. In these applications, the heating element mounted within the dispensing nozzle must be electrically isolated from the charged components of the nozzle through the use of nonconductive materials, such as plastic. However, the nonconductive materials typically employed are not good thermal conductors and therefore make heating of the dispenser nozzle difficult. Moreover, the known alternative of electrically isolating high voltage electrodes within an electrically conductive dispensing nozzle body requires complex internal charging and isolating devices to be incorporated into the nozzle. Additionally, in applications that require electrostatic dispensing of flowable materials on non-conductive substrates, it is not possible to ground the substrate to create the necessary electrostatic attraction between the flowable material and the substrate.

[0005] Accordingly, there is a need for an electrostatic dispensing system which permits the electrostatic nozzle to be heated easily without the need for electrically insulating internal heaters with materials having poor thermal conductivity. There is also a need for an electrostatic dispensing nozzle which does not require the use of complex internal charging and isolating devices in the nozzle. Also, in view of shortcomings in the prior art, it would also be desirable to provide an electrostatic dispensing system which provides uniform patterns of evenly spaced beads of flowable material on a moving non-conductive substrate. It would also be desirable to provide an electrostatic dispensing system which provides an effective electrostatic force for attracting the flowable material to the non-conductive substrate in a controlled, repeatable manner while reducing the potential for arcing in the system.

Summary of the Invention

[0006] To these ends, an electrostatic dispensing system is provided for electrostatically dispensing flowable material on a substantially non-conductive moving substrate. In a preferred embodiment of the present invention, the electrostatic dispensing system preferably includes an elongated dispensing nozzle supported in spaced relationship relative to an electrostatic field generator. The spacing between the dispensing nozzle and electrostatic field generator defines a space for receiving the moving substrate. Preferably, the dispensing nozzle is supported in spaced, non-contacting relationship on one side of the moving substrate, and the electric field generator is supported in spaced, non-contacting relationship on the other side of the moving substrate.

[0007] Flowable material, such as pressure sensitive hot melt adhesive, is supplied to the dispensing nozzle at a controlled rate and low hydraulic pressure from a material delivery system. In accordance with the present invention, the electrostatic field generator is operable to generate an electrostatic field through the moving substrate to attract flowable material from the dispensing nozzle in a series of uniformly spaced, continuous beads or streams. The continuous beads of flowable material are intercepted by the moving substrate and carried away as parallel beads on the surface of the moving substrate facing the dispensing nozzle.

[0008] The dispensing nozzle preferably comprises a pair of mating die bodies which include an internal shim and grounded distribution plate to define an elongated dispensing slot along a lower edge of the nozzle. The distribution plate has a series of uniformly spaced teeth extending slightly beyond the lower edge of the dispensing nozzle which define the even spacing of the continuous material beads deposited on the moving substrate when the longitudinal axis of the dispensing nozzle is arranged perpendicularly to the direction of travel of the moving substrate. To change the spacing between the deposited beads of material, the dispensing nozzle is preferably mounted so its longitudinal axis can be rotated at an angle relative to the direction of travel of the moving substrate. As the relative angle between the longitudinal axis of the dispensing nozzle and the direction of travel of the moving substrate is increased, the spacing between the adjacent beads is decreased. As the dispensing nozzle of the present invention is grounded rather than being charged by a high voltage power supply, the dispensing nozzle may be made of metal or any other suitable material having good thermal conductivity for improved heating of the nozzle. Moreover, the grounded dispensing nozzle eliminates the need for incorporating any complex internal charging or isolating devices in the nozzle.

[0009] The electrostatic field generator includes an electrostatic cable which is coupled at one end to an electrostatic power supply. The other end of the electrostatic cable terminates in a conductive end. The conductive end of the electrostatic field generator is preferably coupled to one side of a resistor through a conductive spring, while the other side of the resistor is preferably coupled to an elongated conductive sleeve. An insulative sleeve is mounted about the conductive end of the electrostatic cable and the resistor, and the conductive sleeve is mounted about the insulative sleeve.

[0010] The conductive sleeve is preferably supported in spaced, non-contacting relationship below the moving substrate to generate an electrostatic field through the moving substrate and thereby attract flowable material from the dispensing nozzle to be dispensed on the other side of the substrate. The resistor preferably has a resistance value in a range from about 150 Mohms to about 200 Mohms to limit current through the electrostatic cable and thereby permit a higher electrostatic voltage to be used. The reduced current and higher electrostatic voltage permit an increased electrostatic force for attracting the flowable material from the dispensing nozzle to the substrate with increased accuracy and repeatability, while reducing the potential for arcing in the system to improve safety.

[0011] In accordance with a preferred method of the present invention, flowable material is dispensed from one side of a moving substrate while an electrostatic field is generated on the other side of the moving substrate. The moving substrate may be substantially non-conductive, and the flowable material may comprise a heat responsive material such as hot melt adhesive. The generated electrostatic field attracts the flowable material in a plurality of continuous beads which intersect the moving substrate on the dispensing side of the moving substrate. Preferably, the flowable material is dispensed from an elongated dispensing slot which is supported in non-contacting relationship on the dispensing side of the moving substrate. The electrostatic field is preferably generated from an elongated conductor which is supported on the opposite side of the moving substrate.

[0012] The electrostatic dispensing apparatus and method of the present invention provide electrostatic dispensing of flowable material in uniform continuous beads on a substantially non-conductive moving substrate. The dispensing nozzle and electrostatic field generator of the present invention are operable to produce controlled patterns of flowable material on a moving substrate with low add-on weight, accurate bead placement and high pattern repeatability.

[0013] The above features and advantages of the present invention will be better understood with reference to the accompanying figures and detailed description.

Brief Description of the Drawings

[0014] Reference will now be made to the accompanying figures from which the novel features and advantages of the present invention will be apparent:

Fig. 1 is a perspective view of an electrostatic dispensing system in accordance with the present invention for electrostatically dispensing flowable material on a moving substrate;

Fig. 2 is a side elevational view showing a preferred arrangement of the dispensing nozzle, electrostatic field generator and moving substrate of the electrostatic dispensing system shown in Fig. 1;

Fig. 2A is a diagrammatic view showing a preferred mounting of the dispensing nozzle of Fig. 1 for rotation about a vertical axis relative to the direction of travel of the moving substrate;

Fig. 3 is an exploded perspective view showing components of the dispensing nozzle shown in Figs. 1 and 2; and

Fig. 4 is a cross-sectional view of the electrostatic field generator taken along line 4-4 in Fig. 2.

Detailed Description of the Invention

[0015] With reference to the figures, and to Fig. 1 in particular, an electrostatic dispensing system 10 in

accordance with the principles of the present invention is shown for electrostatically dispensing flowable material 12, such as pressure sensitive hot melt adhesive, for example, on a moving substrate 14. The electrostatic dispensing system 10 includes an elongated dispensing nozzle 16 which is connected for fluid communication to a material delivery system 18 through a flow tube 20 mounted on the nozzle. A dispensing gun body and gun module 21 is provided in the fluid path to control flow of material 12 through the dispensing nozzle 16. The dispensing nozzle 16 is preferably mounted in spaced, non-contacting relationship above the moving substrate 14 which travels relative to the nozzle in a direction represented by arrow 22 in Figs. 1 and 2. The moving substrate 14 may be a web of bottom sheet material, for example, which receives a uniform, continuous pattern of adhesive streams or beads 24 from the dispensing nozzle 16 before being joined with a web of top sheet material (not shown).

[0016] The electrostatic dispensing system 10 further includes an electrostatic field generator 26 which is preferably mounted in spaced, non-contacting relationship below the moving substrate 14. The preferred spaced arrangement of dispensing nozzle 16 and electrostatic field generator 26 defines a receiving space 27 for moving substrate 14 as shown in Figs. 1 and 2. As will be described in more detail below, the electrostatic field generator 26 is operable to generate an electrostatic field through the movable substrate 14, which itself may be a substantially non-conductive material, to attract or draw the beads 24 of flowable material from the dispensing nozzle 16 in a direction which intersects the moving substrate 14. In this way, a uniform, continuous pattern of streams or beads 24 may be formed across an upper surface 28 of the moving substrate 14 before it is joined with a second substrate to form a multi-ply, bonded structure. For example, electrostatic dispensing system 10 may be used in a diaper production line to adhesively join a polymeric liquid barrier sheet to a nonwoven absorbent layer, or in a multi-ply tissue paper production line wherein individual plies of tissue paper must be adhesively joined together. Those skilled in the art will readily appreciate the various applications to which the present invention is susceptible.

[0017] Referring to Figs. 1-3, the dispensing nozzle 16 preferably includes mating die bodies 30a and 30b which are joined through threaded fasteners 32 extending through bores 34 in die body 30b and tapped bores 35 in die body 30a (Fig. 3). Die bodies 30a and 30b are preferably made of metal or other suitable material which is a good thermal conductor. A pair of dowel pins 36 (Fig. 3) extend through bores 38 in the die bodies 30a and 30b to insure proper registration of the die bodies as they are heated during the dispensing of flowable material 12 as will be discussed in more detail below.

[0018] As shown most clearly in Figs. 2 and 3, die body 30a includes a bore 40 configured for receiving a lower portion of the flow tube 20, and a fluid passageway 42 which extends from bore 40 to a hanger-shaped channel 44 which is machined into a face 46 of the die body 30a. Die body 30b includes an elongated bore 48 extending longitudinally through the die body which receives a cylindrical heater 50 for heating the dispensing nozzle 16 during the electrostatic dispensing process. A housing 52 (Fig. 1) associated with the heater 50 is joined to die body 30b through threaded fasteners 54 which extend through bores 56 in die body 30b. Heater 50 is preferably a 365 Watt, low amperage heater which is suitable for rapidly heating dispenser nozzle 16 to a controlled temperature during the dispensing process. An electrical cord set 58 (Fig. 1) extends through housing 52 and is coupled to heater 50. Cord set 58 includes a connector (not shown) at a remote end for connection to a suitable source of electrical power.

[0019] Further referring to Figs. 2 and 3, dispensing nozzle 16 preferably includes a shim 60 and a distribution plate 62 which are joined between the inner faces of die bodies 30a and 30b through fasteners 32 to define an elongated dispensing outlet 64 along a lower edge 66 of the dispensing nozzle 16. Preferably, the die bodies 30a and 30b are tapered near respective lower edges 68a and 68b to form a pair of die lips 70a and 70b proximate the dispensing outlet 64.

[0020] As shown most clearly in Fig. 3, shim 60 includes a hanger-shaped cut-out region 72 which is defined by a peripheral edge 74. Peripheral edge 74 of cut-out region 72 is configured to extend approximately in register with a peripheral edge 76 of the hanger-shaped channel 44 formed in the face 46 of die body 30a. In combination with the hanger-shaped channel 44 of die body 30a on one side, and distribution plate 62 on the other side, the cut-out region 72 in shim 60 defines an elongated slot at the dispensing outlet 64 for dispensing flowable material 12 along a lower portion of distribution plate 62 which extends slightly beyond die lips 70a and 70b. The thickness of shim 60 is chosen to insure even distribution of flowable material 12 in the cut-out region 72 for uniform dispensing through the elongated slot. The hydraulic pressure of material 12 in the dispensing system 10 is preferably controlled through an orifice plate (not shown) in the gun body 21. Those skilled in the art will appreciate that the flow rate of material 12 could also be controlled through the use of a metering gear head or modulating valve without departing from the spirit or scope of the present invention.

[0021] Referring to Figs. 1-3, the distribution plate 62 preferably terminates in a serrated edge 78 which extends slightly beyond the respective lower edges 68a and 68b of die lips 70a and 70b. For purposes to be described in more detail below, the serrated edge 78 preferably has teeth 80 which have centerlines spaced about 1/4" apart, although other spacings of teeth 80 are possible for providing different spacings of the streams or beads 24 as will be discussed in more detail below. It will be appreciated that the minimal spacing of

teeth 80 must be chosen to insure that the flowable material 12 does not bridge the gap between adjacent teeth 80.

[0022] As shown most clearly in Figs. 1, 2 and 4, the electrostatic field generator 26 is preferably mounted in spaced, non-contacting relationship below the moving substrate 14 through a support structure, such as mounting bracket 82. The electrostatic field generator 26 preferably includes an electrostatic cable 84 which is coupled to an electrostatic power supply 86 (Fig. 1), such as a Model EPU-9 electrostatic power supply commercially available from Nordson Corporation of Westlake, Ohio, assignee of the present invention. Electrostatic power supply 86 is preferably operable to generate between a 5 kV and 50 kV electrostatic field during operation of the electrostatic field generator 26 as will be described in more detail below.

[0023] The electrostatic cable 84 has an internal conductor 88 which is shielded along its length by an insulative covering 90. Electrostatic cable 84 terminates in a conductive end 92 which is preferably coupled to one side 94 of a resistor 96 through a conductive spring 98. While only one resistor 96 is shown, those skilled in the art will readily appreciate that more than one resistor or equivalent components are possible without departing from the spirit or scope of the present invention.

[0024] An insulative sleeve 100, preferably made of DELRIN®, is connected to the electrostatic cable 84 through an intermediate adaptor 102. Insulative sleeve 100 is preferably mounted about the conductive end 92 of the electrostatic cable 84, the conductive spring 98, and the resistor 96. A conductive sleeve 104, preferably made of stainless steel, is mounted about a remote end of the insulative sleeve 100. The conductive sleeve 104 is preferably coupled to the other side 106 of resistor 96 through a conductive dowel pin 108 which extends through bores 110 in insulative sleeve 100 and bores 112 in conductive sleeve 104. Preferably, resistor 96 has a resistance value in a range from about 150 Mohms to about 200 Mohms to limit current through the electrostatic cable 84 and therefore substantially reduce potential arcing with dispensing nozzle 16 during the electrostatic dispensing process. An end cap 114 is attached to a remote end of the conductive sleeve 104 and the insulative sleeve 100 to retain the conductive dowel pin 108 in the receiving bores 110 and 112.

[0025] In a preferred operation of the electrostatic dispensing system, the dispensing nozzle 16 is supported through support structure 115 in non-contacting relationship above the upper surface 28 of the moving substrate 14 while the electrostatic field generator 26 is preferably supported in non-contacting relationship below the moving substrate 14 through mounting bracket 82. For purposes to be described below, the dispensing nozzle 16 is mounted so its longitudinal axis can be rotated at an angle relative to the direction of travel 22 of the moving substrate 14. Those skilled in the art will appreciate that support structure 115 for supporting dispensing nozzle 16 and the preferred mounting bracket 82 for supporting electrostatic field generator 26 do not form a part of the present invention per se, and therefore may comprise components of a single support structure or multiple structures as shown in the figures.

[0026] Before the electrostatic dispensing operation begins, the dispensing nozzle 16 is heated to a controlled temperature through heater 50, and the dispensing nozzle 16 is grounded as shown in Fig. 1, thereby grounding distribution plate 62 in contact with flowable material 12. Flowable material 12 is delivered from delivery system 18 at a controlled rate and at a low hydraulic pressure to the dispensing nozzle 16 through dispensing gun body and gun module 21 and flow tube 20. Delivery system 18 is preferably a Model 3500 Hot Melt Unit commercially available from Nordson Corporation, while dispensing gun body and gun module 21 preferably comprises respective Models H20-T and H20 LBS commercially available from Nordson Corporation, assignee of the present invention. Flowable material 12 may comprise a pressure sensitive hot melt adhesive, such as National Starch's 34-5590, for example, which has the desired rheological and adhesive properties for the electrostatic dispensing application. When the electrostatic power supply 86 is turned on, the electrostatic field generator 26 generates a 5 kV to 50 kV electrostatic field between the conductive sleeve 104 and the dispensing nozzle 16 which passes through the moving substrate 14. Moving substrate 14 may comprise a non-conductive woven or nonwoven web of material, or a polymeric film, for example, which permits the electrostatic field generated by the electrostatic field generator 26 to pass through the web.

[0027] As shown most clearly in Figs. 1 and 2, as flowable material 12 exits the dispensing outlet 64, it is carried along a portion of the distribution plate 62 which extends past the die lips 70a and 70b. The electrostatic field generated by the electrostatic field generator 26 through the moving substrate 14 attracts and pulls the streams or beads 24 of flowable material generally from the spaced points 116 of teeth 80 in a direction which intersects the moving substrate 14. Thus, the spacing of the points 116 of teeth 80, such as 1/4" apart for example, generally defines the spacing of the streams or beads 24 as they are intercepted and carried away by the moving substrate 14 when the longitudinal axis of the dispensing nozzle 16 is arranged perpendicularly to the direction of travel 22 of moving substrate 14.

[0028] As shown most clearly in Fig. 2A, it has been found that by rotating the longitudinal axis of the dispensing nozzle 16 about a vertical axis, to thereby position the longitudinal axis of the dispensing nozzle 16 at an angle relative to the direction of travel 22 of moving substrate 14, a closer fixed bead pattern, i.e. less than 1/4", may be achieved. As this relative angle is increased, the spacing between the adjacent beads 24 is decreased, thereby permitting a close parallel bead

pattern which is not limited by the spacing between the adjacent teeth 80. Those skilled in the art will appreciate that the longitudinal length of dispensing nozzle 16 and the spacing of points 116 may be selected in accordance with the desired overall width of the material pattern and the required spacing of the individual continuous beads 24.

[0029] As shown in Figs. 1 and 2, the beads 24 are deposited on the upper surface 28 of the moving substrate 24 generally parallel to the direction of travel of the web as represented by arrow 22. By varying the speed of the moving substrate 14 and by varying the distance between adjacent beads 24, it is possible in accordance with the principles of the present invention to control the beadwidth of each bead 24 and the add-on weight of flowable material 12 on a material substrate 14. For example, by varying the speed of the moving substrate 14 between about 500 f.p.m. and about 1000 f.p.m., and by varying the distance between adjacent beads 24, it is possible to form beads 24 of flowable material having an approximate diameter which varies between about .001 and about .002 inches, thereby giving an approximate add-on weight which varies between about .088 g/m^2 and about .336 g/m^2. Thus, while the spacing and diameter of the beads 24 formed by the electrostatic dispensing process is generally considered to be a function of the flow rate of flowable material 12 through dispensing outlet 64, the rheological properties of the flowable material 12, and the electrostatic force generated by the electrostatic field generator 26 attracting the beads, the provision of the teeth 80 on the serrated edge 78 of distribution plate 62 greatly improves the uniformity of spaced bead pattern and makes the electrostatic dispensing nozzle 16 less sensitive to operating parameters.

[0030] Those skilled in the art will appreciate that the present invention provides an electrostatic dispensing system which is readily adaptable for a number of different dispensing applications. The arrangement of the grounded dispensing nozzle 16 and electrostatic field generator 26 on opposite sides of the moving substrate 14 in accordance with the present invention provides for electrostatic dispensing of flowable material on nonconductive substrates. As dispensing nozzle 16 is grounded and preferably made of metal, it is capable of being rapidly heated by heater 50 to a controlled temperature which is suitable for the particular dispensing application. The provision of teeth 80 along a lower edge of the dispensing nozzle 16 provides uniform patterns of evenly spaced, continuous beads 24 on the upper surface 28 of moving substrate 14 with very low add-on weight. Moreover, the construction of the electrostatic field generator 26 provides an increased electrostatic force for attracting flowable material 12 to moving substrate 14 in accurate, highly repeatable patterns while at the same time reducing the potential for arcing in the system.

[0031] From the above disclosure of the general principles of the present invention and the preceding detailed description of preferred embodiments, those skilled in the art will readily comprehend the various modifications to which the present invention is susceptible. For example, while dispensing nozzle 16 and electrostatic field generator 26 have been described as being respectively mounted "above" and "below" moving substrate 14, those skilled in the art will appreciate that other orientations of the components and substrate are possible without departing from the spirit and scope of the present invention. In particular, the arrangement of the dispensing nozzle 16 and electrostatic field generator 26 may be reversed, with the dispensing nozzle 16 located below the moving substrate 14 and the electrostatic field generator 26 located above the moving substrate 14. With this arrangement, the flowable material 12 is dispensed upwardly toward the moving substrate 14 rather than downwardly as shown in Fig. 1. Moreover, while an elongated dispensing outlet 64 has been shown and described in detail in connection with a preferred embodiment of the present invention, it is equally contemplated that the elongated dispensing outlet 64 of nozzle 16 could be substituted with a series of evenly spaced nozzle outlets or orifices having means to direct dispensing of the continuous beads 24 toward the moving substrate 14. The invention in its broader aspects is therefore not limited to the specific details and illustrative example shown and described. Accordingly, departures may be made from such details without departing from the spirit or scope of Applicants' general inventive concept. Therefore, Applicants desire to be limited only by the full legal scope of the following claims.

Claims

1. Apparatus for electrostatically dispensing flowable material on a substantially non-conductive moving substrate, comprising:

    a support structure;

    a nozzle supported by said support structure in a first location, said nozzle being operable to dispense flowable material from a dispensing outlet thereof; and

    an electrostatic field generator supported by said support structure in a second location, said first and second locations being spaced relative to each other to define a receiving space for a moving substrate therebetween,

    whereby said electrostatic field generator is operable to generate an electrostatic field through the moving substrate for attracting flowable material from said dispensing outlet of said nozzle in a direction which intersects said moving substrate to thereby deposit said flowa-

ble material on one side thereof.

2. The apparatus of claim 1 wherein said nozzle has first and second die bodies which define a material cavity therebetween; and

further comprising a heater disposed in one of said first and second die bodies and operable to heat said flowable material in said material cavity.

3. The apparatus of claims 1 or 2 wherein said dispensing outlet comprises an elongated slot.

4. The apparatus of claims 1 or 2 wherein said electrostatic field generator:

(a) comprises an elongated conductor coupled to an electrostatic power supply; or

(b) is operable to attract said flowable material from said dispensing outlet of said nozzle in a plurality of continuous beads.

5. The apparatus of claims 1 or 2 wherein said dispensing outlet of said nozzle has a longitudinal axis oriented:

(a) substantially perpendicular to a direction of travel of said moving substrate; or

(b) at an angle relative to a direction of travel of said moving substrate.

6. The apparatus of claim 4 wherein said elongated conductor has a longitudinal axis oriented substantially perpendicular to a direction of travel of said moving substrate.

7. The apparatus of claims 1 or 2 wherein said first and second die bodies terminate at respective first and second die lips proximate said dispensing outlet.

8. The apparatus of claims 1 or 2 further comprising a distribution plate mounted between said first and second die bodies to ground said flowable material prior to being dispensed from said dispensing outlet.

9. The apparatus of claim 8 wherein said distribution plate terminates in an elongated serrated edge proximate said dispensing outlet.

10. A method of electrostatically dispensing flowable material on a substantially non-conductive moving substrate, comprising:

moving a substrate;

dispensing flowable material toward one side of said moving substrate; and

generating an electrostatic field on the opposite side of said moving substrate to attract said flowable material onto the one side thereof.

11. The method of claim 10 wherein said flowable material comprises hot melt adhesive.

12. The method of claims 11 or 12 wherein said dispensing step further comprises dispensing said flowable material in a plurality of spaced continuous beads which intersect said moving substrate.

13. The method of claims 11 or 12 wherein said dispensing step further comprises dispensing said flowable material from an elongated dispensing slot supported in non-contacting relationship on the one side of said moving substrate.

14. The method of claims 11 or 12 wherein said dispensing step further comprises grounding said flowable material prior to being dispensed.

15. An electrostatic field generator for use with a dispenser of flowable material in an electrostatic dispensing process, comprising:

an electrostatic power supply having an electrostatic cable coupled thereto, said electrostatic cable terminating in a conductive end;

a resistive element coupled to said conductive end of said electrostatic cable;

an insulative sleeve mounted substantially about said conductive end of said electrostatic cable and said resistive element; and

a conductive sleeve mounted substantially about said insulative sleeve and coupled to said conductive end of said electrostatic cable and said resistive element whereby an electrostatic field is generated proximate said conductive sleeve to attract said flowable material from said dispenser.

16. The electrostatic field generator of claim 15 wherein said conductive sleeve is coupled to one of the following:

(a) said conductive end of said electrostatic cable through said resistive element; or

(b) said resistive element through a conductor which extends through said insulative sleeve.

17. The electrostatic field generator of claim 15 wherein said resistive element is at least one the following:

(a) coupled to said conductive end of said electrostatic cable through a conductive spring element; or

(b) comprises a resistor having a resistance value in a range from about 150 Mohms to about 200 Mohms.

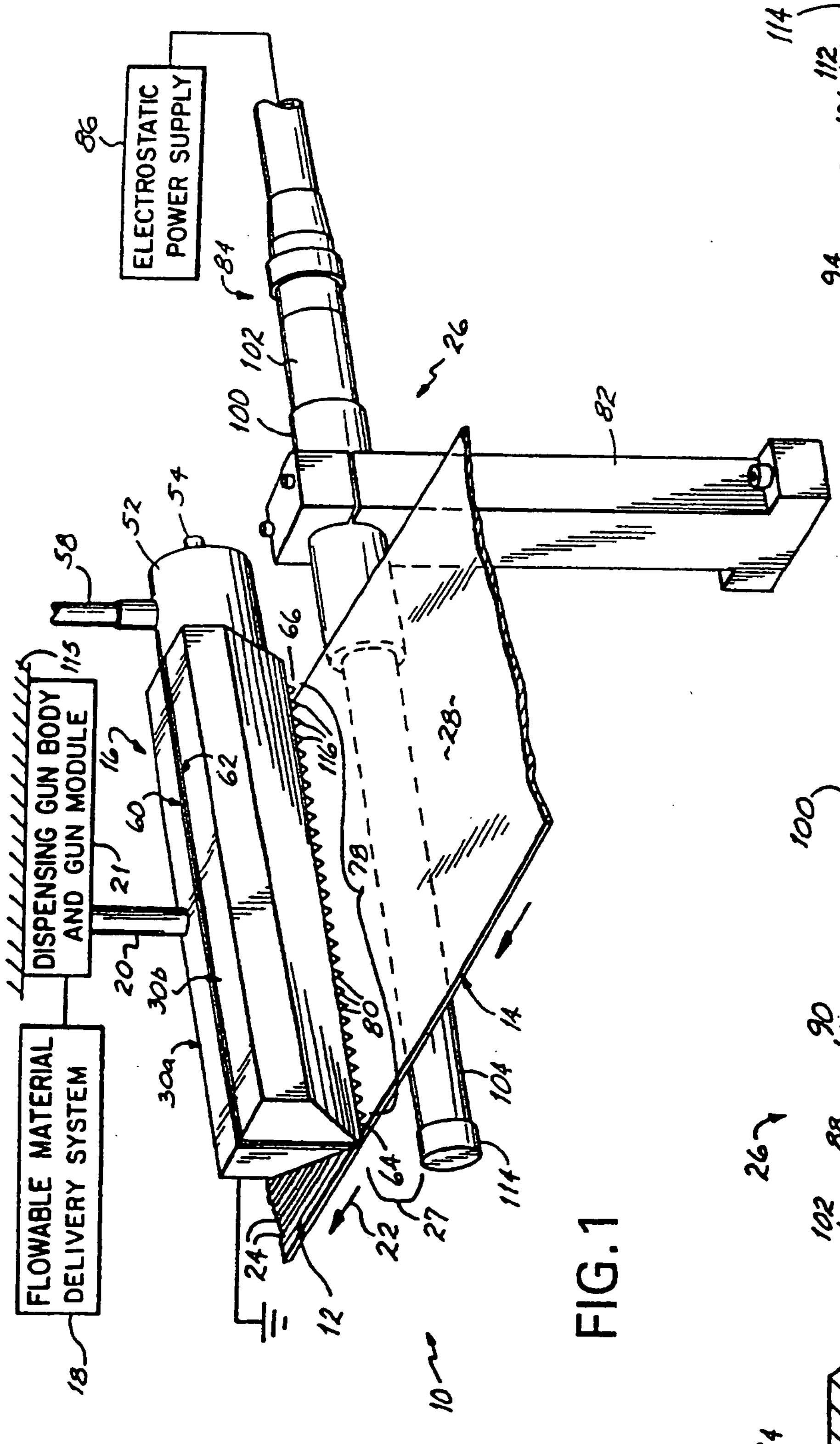
ELECTROSTATIC
POWER SUPPLY
DISPENSING GUN BODY
AND GUN MODULE
FLOWABLE MATERIAL
DELIVERY SYSTEM

FIG.1

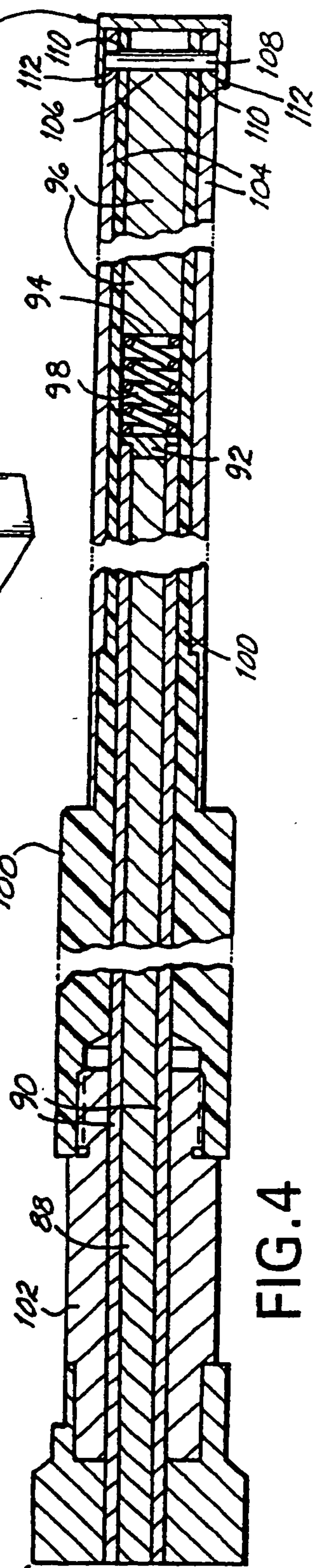

FIG.4

FIG.2

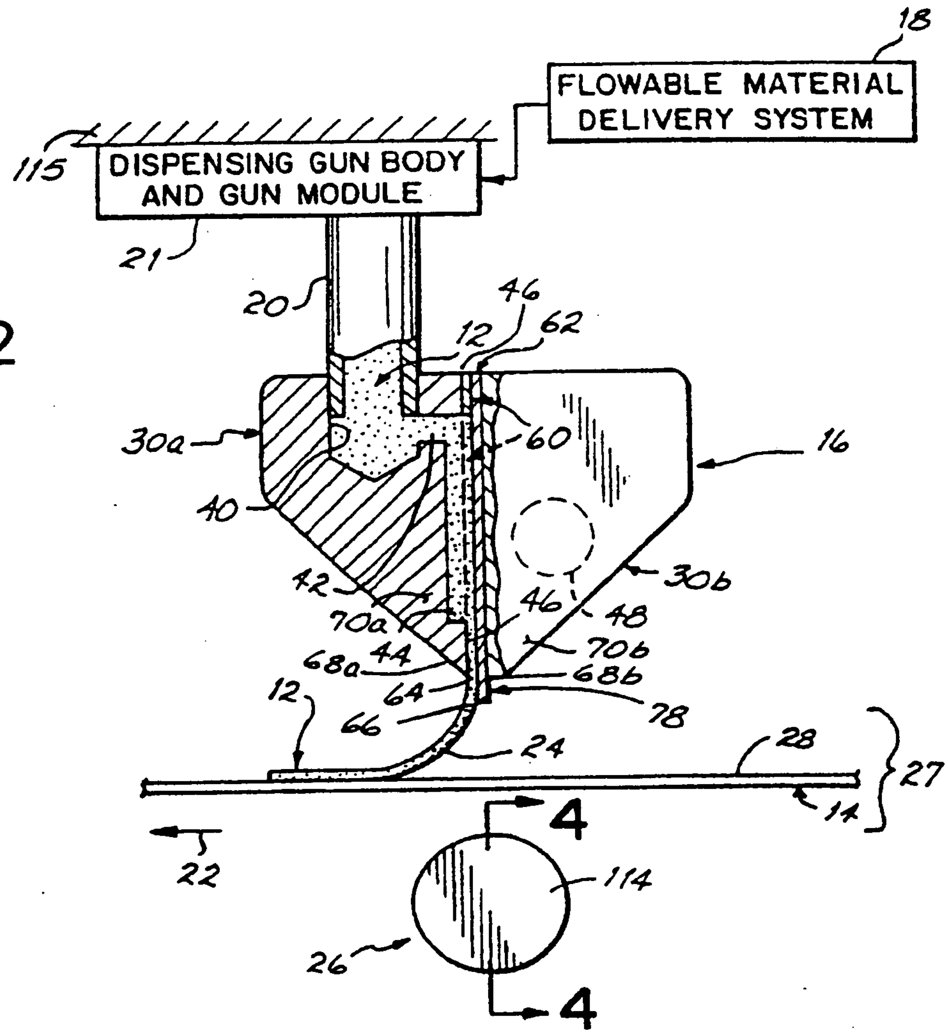
18
FLOWABLE MATERIAL DELIVERY SYSTEM
115
DISPENSING GUN BODY AND GUN MODULE
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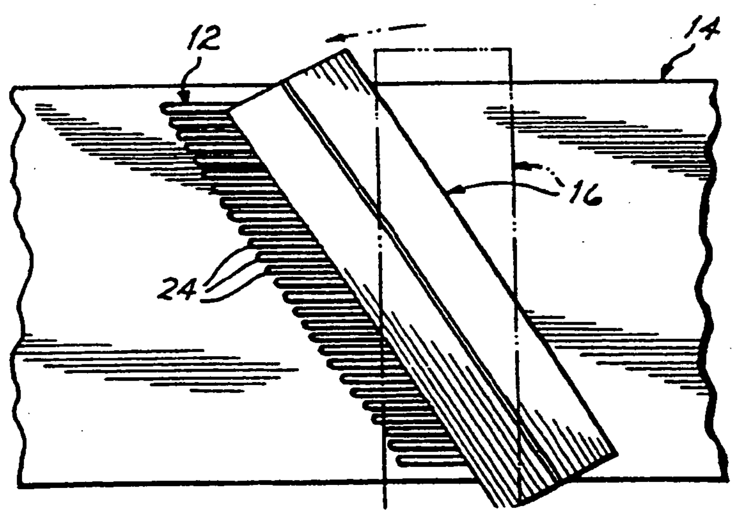
FIG.2A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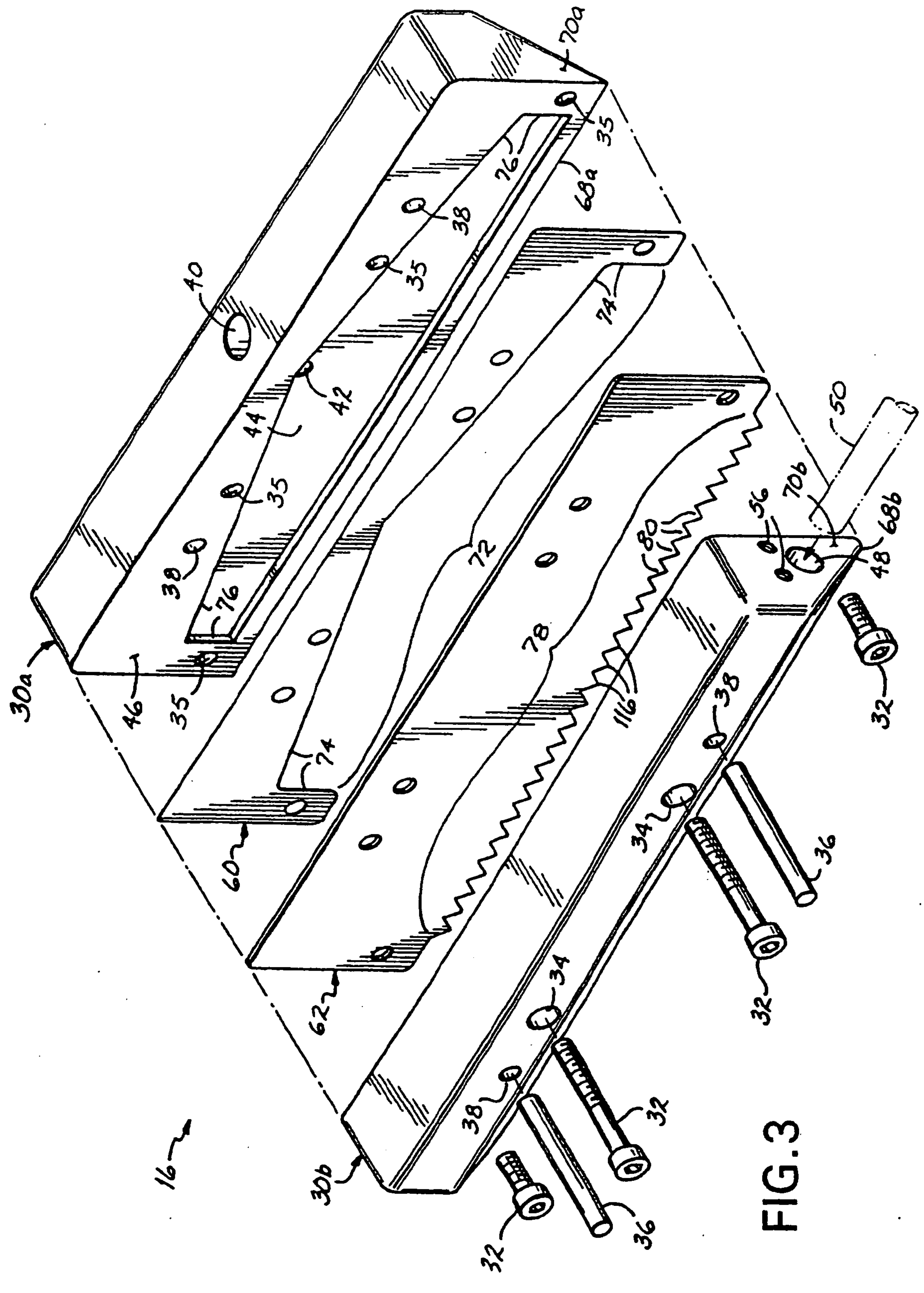
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FIG.3